INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

PRIORITY DOCUMENT

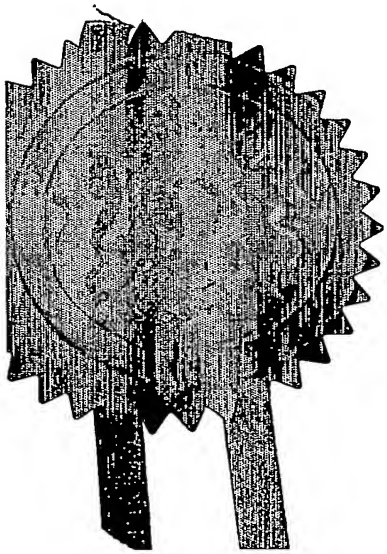
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.



Signed

Dated 10 July 2003

FEE

Patents Form 1/77

Patents Act 1977
(Rule 16)

The Patent Office

1/77

THE PATENT OFFICE
A
31 MAY 2002
RECEIVED BY FAX

The Patent Office

Cardiff Road
Newport
South Wales
NP9 1RH

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference — P/63653.GBA/VMIC 31MAY02 E722931-1 D00314 31 MAY 2002 P01/7700 0.00-0212630.8

2. Patent application number *(The Patent Office will fill in this part)* — 0212630.8

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Marconi Applied Technologies Limited
One Bruton Street
London
W1X 8AG

Patents ADP number *(if you know it)* 7803513001

If the applicant is a corporate body, give the Country/state of its incorporation — **United Kingdom**

4. Title of the invention — **MAGNETRONS**

5. Name of your agent *(if you have one)* — **N. Hucker**

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Marconi Intellectual Property
Marrable House
The Vineyards
Great Baddow
Chelmsford
Essex CM2 7DS

Patents ADP number *(if you know it)* 8225245001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
   a) any applicant named in part 3 is not an inventor, or
   b) there is an inventor who is not named as an applicant, or
   c) any named applicant is a corporate body.
   See note (d))

YES

Patents Form P1/77

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	(0)
Description	9
Claim(s)	4
Abstract	(0)
Drawings	7

10. If you are also filing any of the following, state how many against each item.

Priority documents	(0)
Translations of priority documents	(0)
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	(0)
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	(0)
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Nerys Hucker Date 31/05/02

12. Name and daytime telephone number of person to contact in the United Kingdom

Nerys Hucker
01245 493 493 ext.3122

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

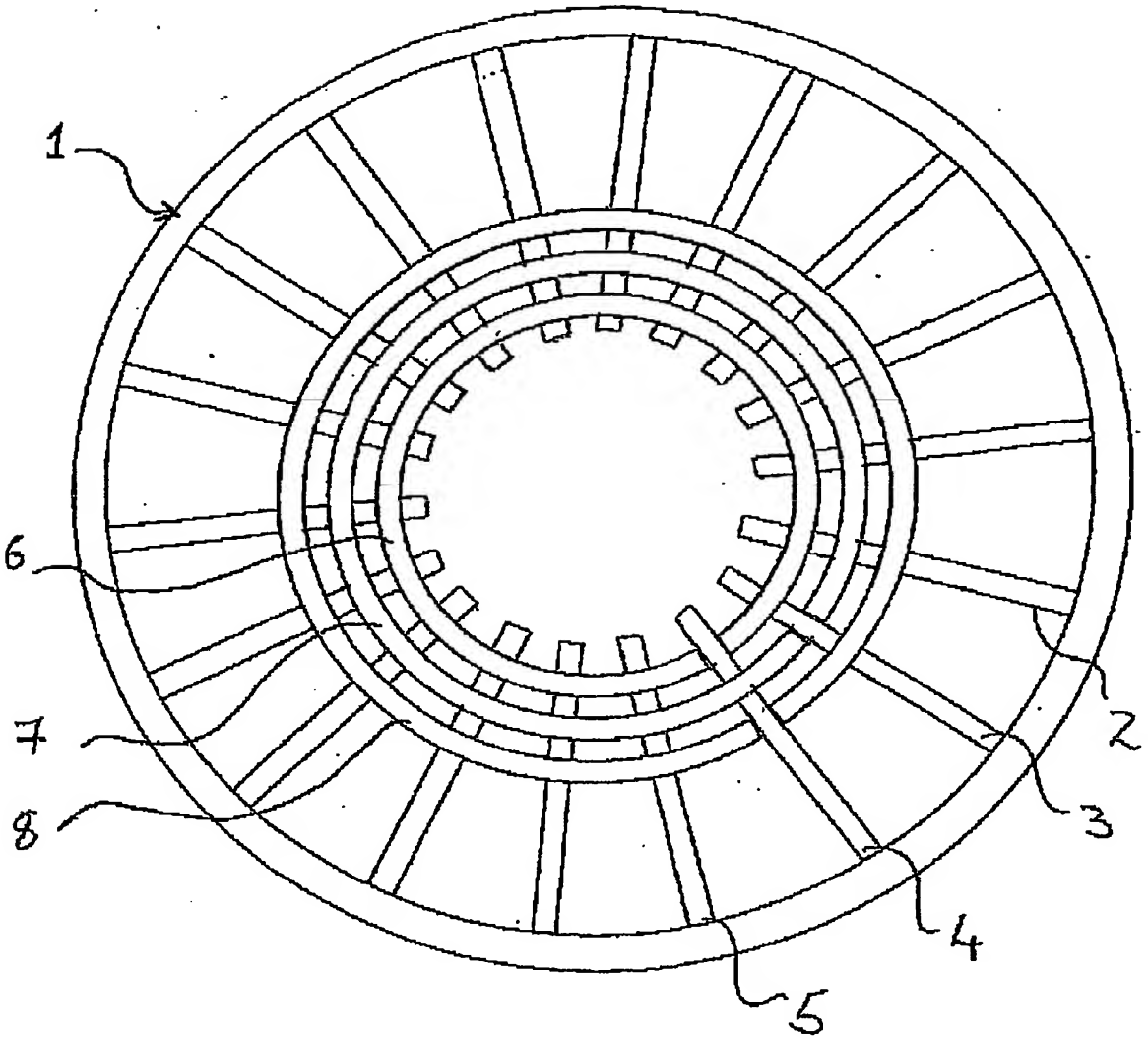


FIG. 1 (PRIOR ART)

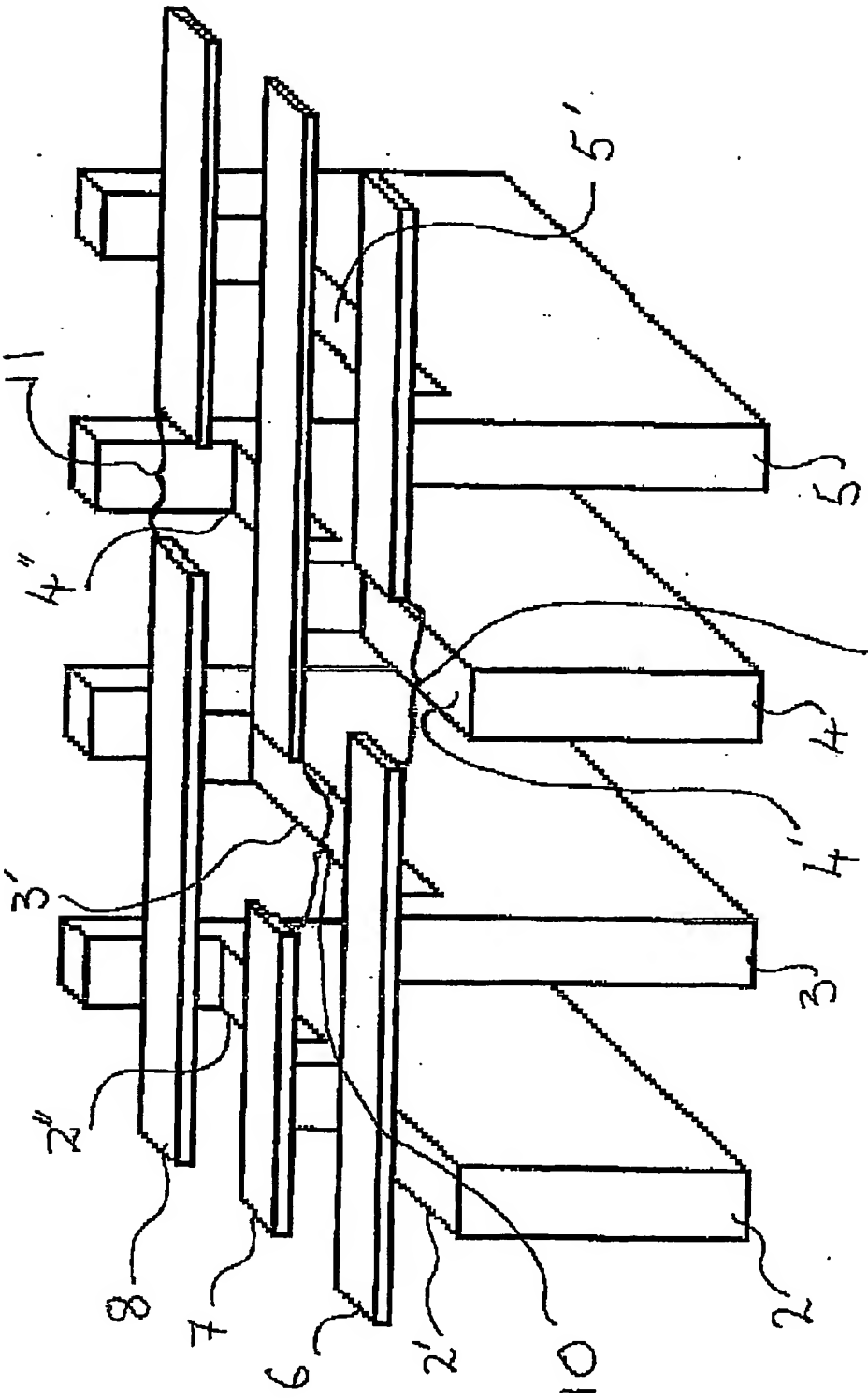


FIG. 2 (PRIOR ART)

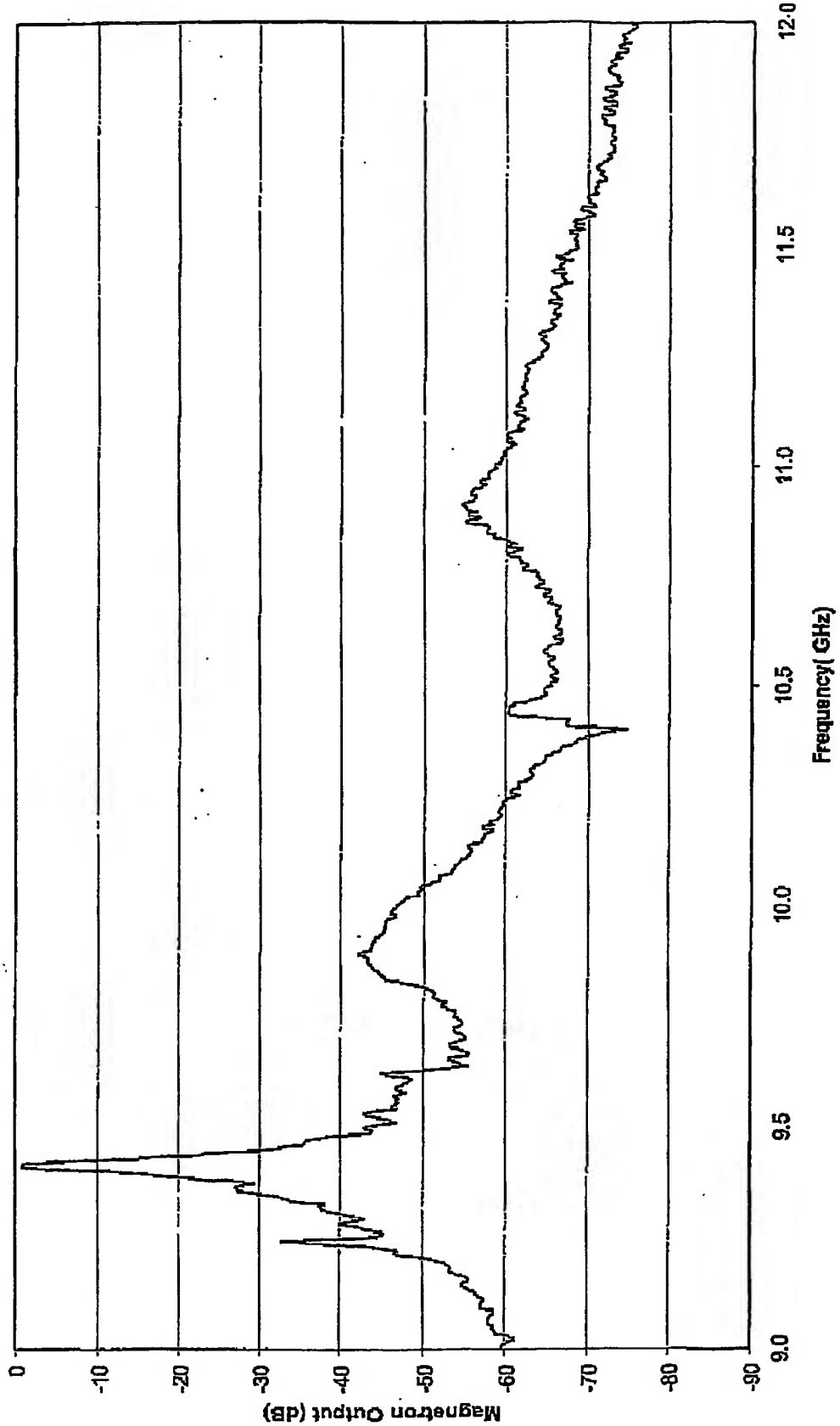


FIG. 3 (PRIOR ART)

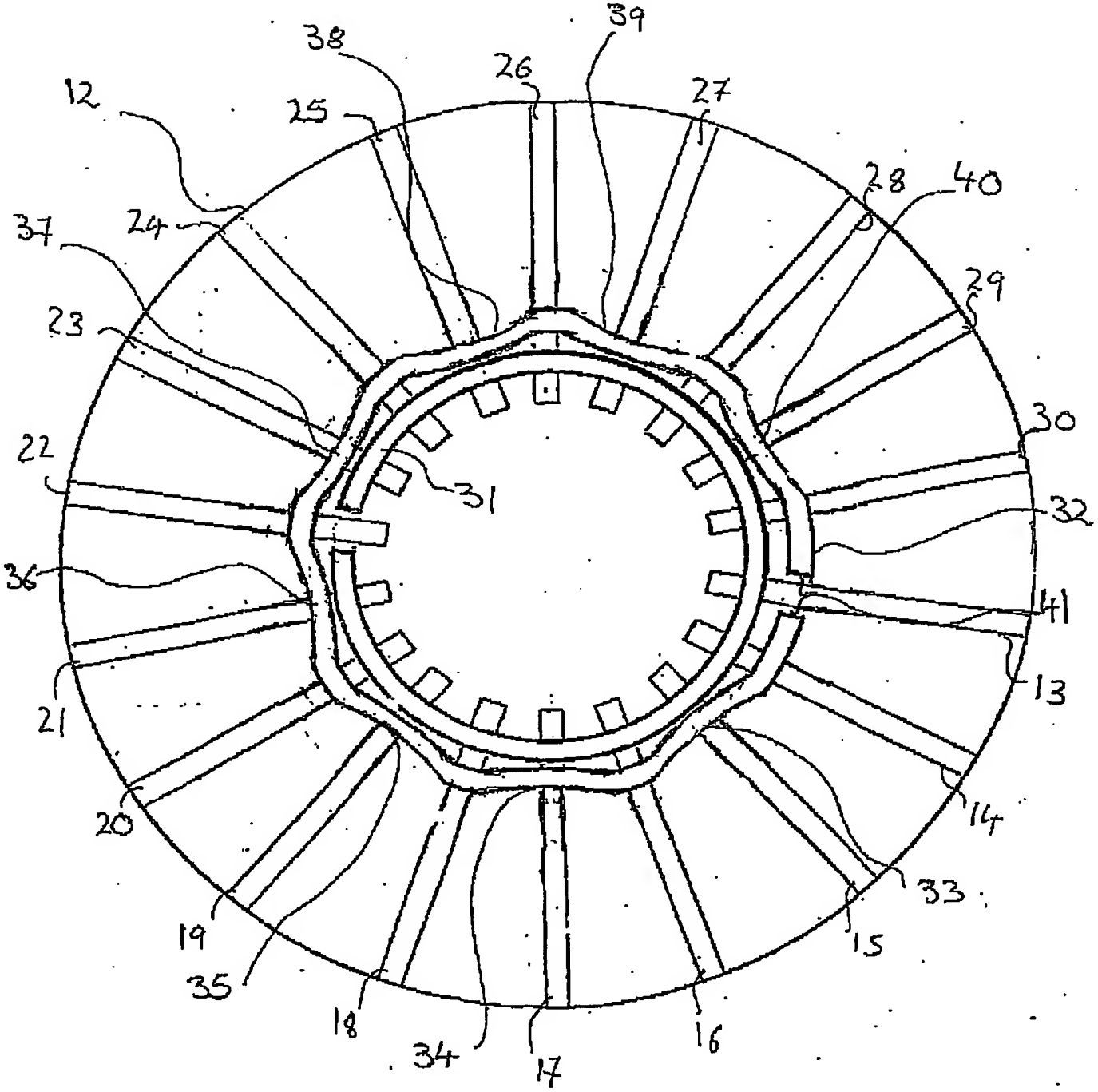

39
38
26
27
12
25
28
40
37
24
29
23
30
22
31
32
36
41
13
21
14
20
33
19
15
35
18
34
17
16

FIG. 4.

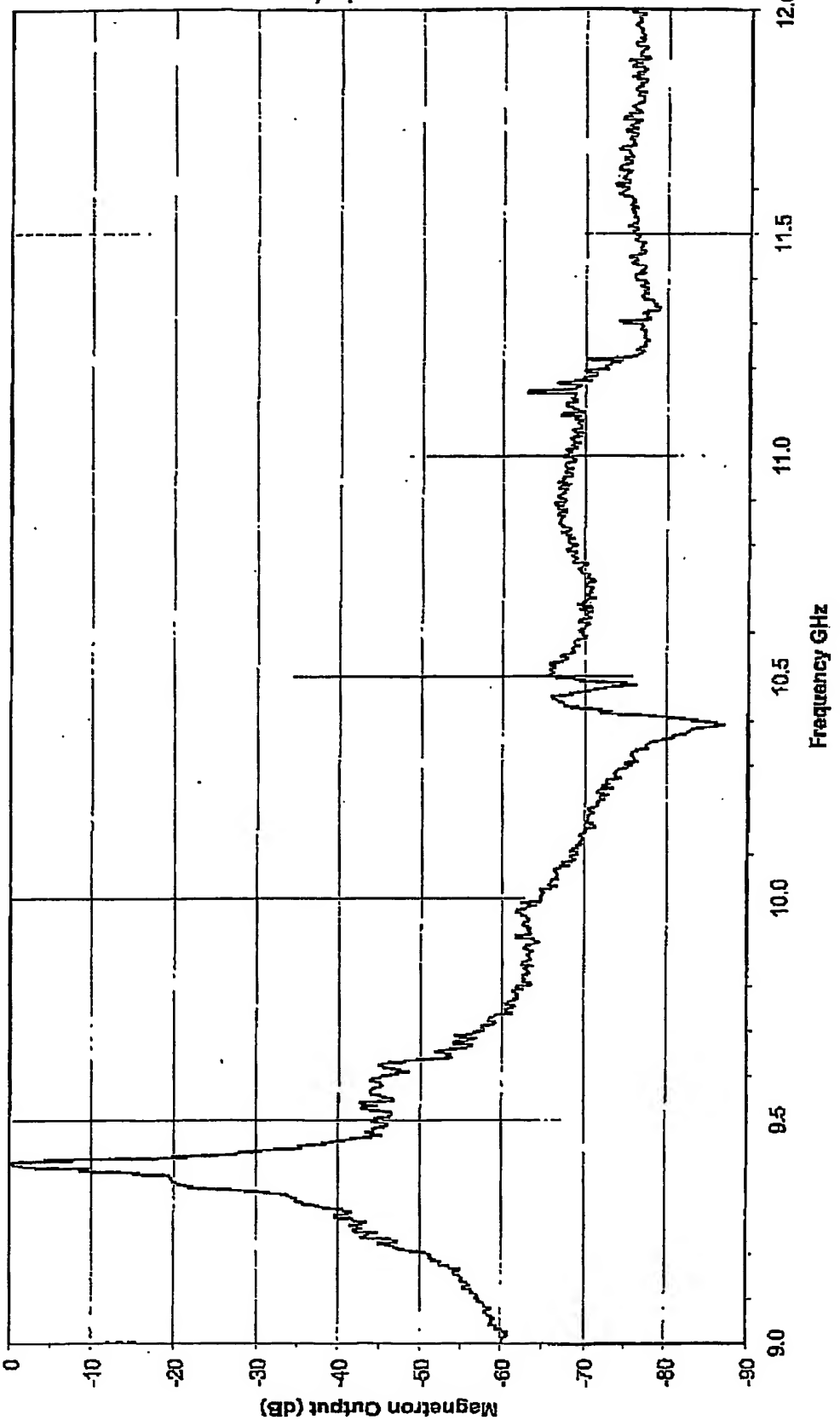

Magnetron Output (dB)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
9.0
9.5
10.0
10.5
11.0
11.5
12.0
Frequency GHz

FIG. 5

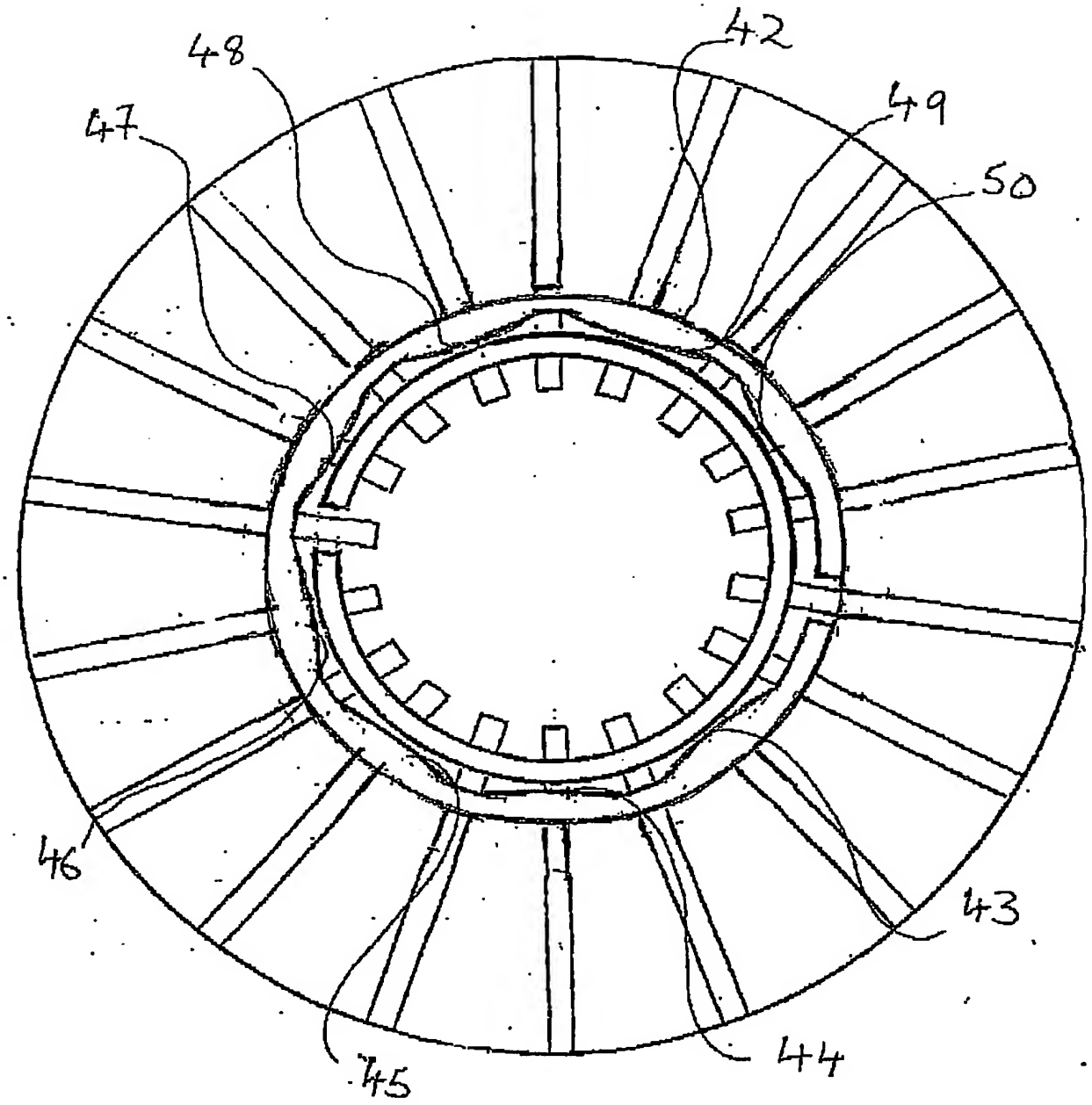


FIG. 6

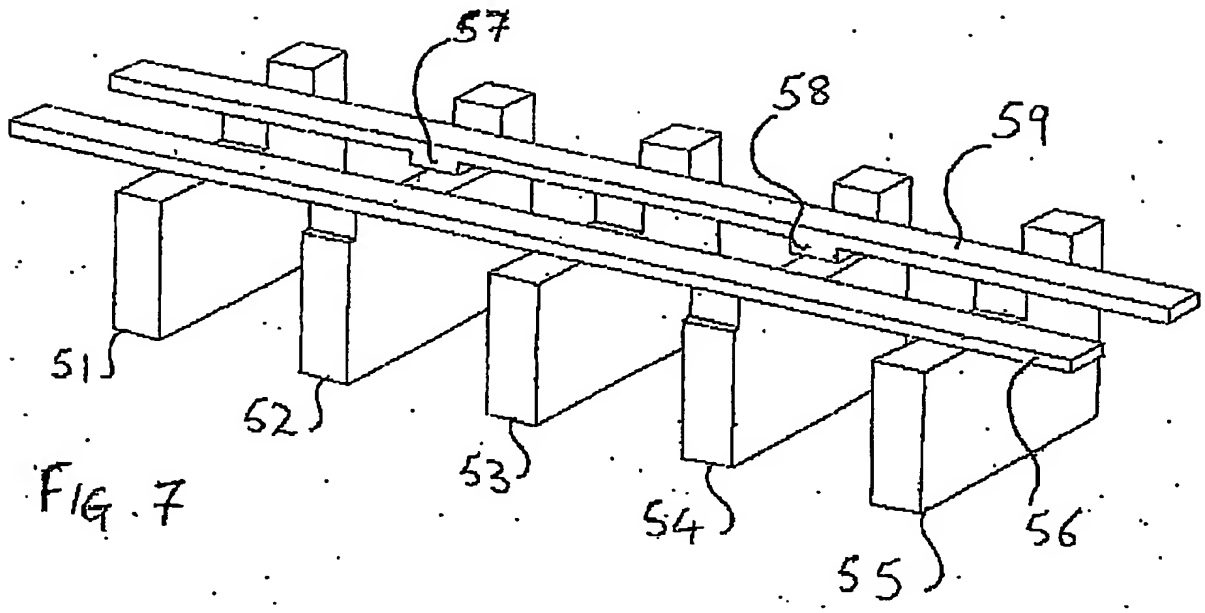


FIG. 7

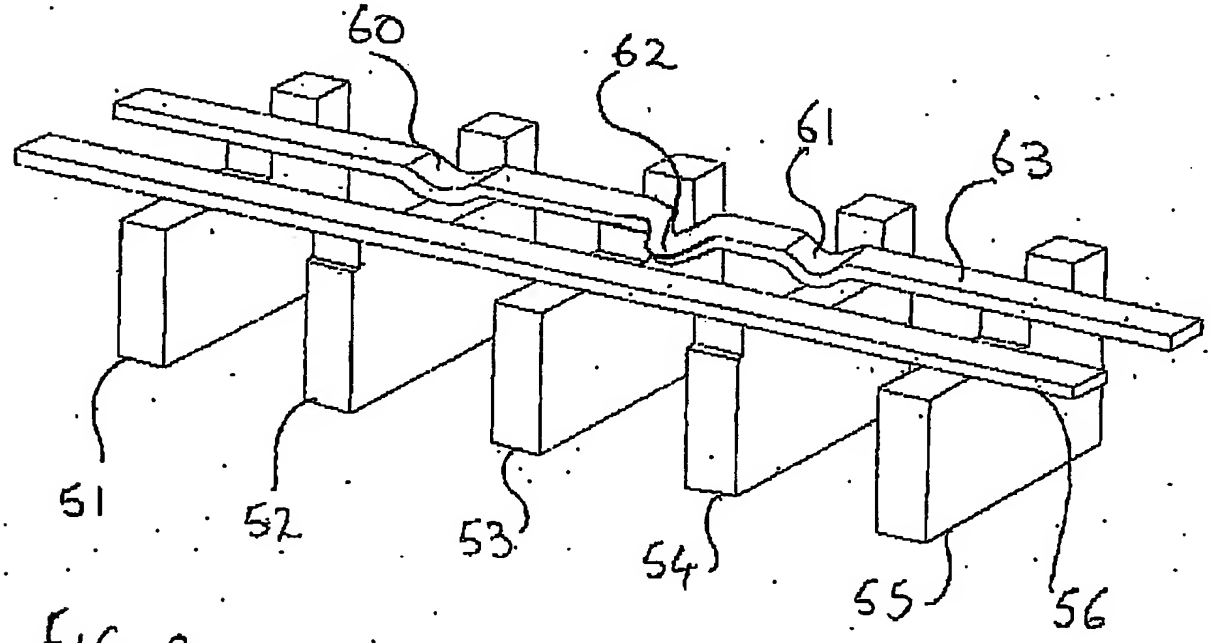


FIG. 8.

MAGNETRONS

This invention relates to magnetrons.

Magnetrons are well-known vacuum electron discharge devices used to generate electromagnetic fields in the microwave frequency range. A typical magnetron comprises a cylindrical cathode, a cylindrical anode surrounding the cathode and a plurality of resonant cavities formed in the anode by either slots or vanes. An electric field is established between the cathode and the anode, and a magnetic field is applied perpendicular to the electric field in the so-called interaction region, which is the evacuated space between the cathode and the resonant cavities in the anode. When the value of E/H is suitable, electrons emitted from the cathode interact with the electric and magnetic fields to generate microwave energy at a frequency determined by the parameters and the resonance characteristics of the cavities.

A known problem with magnetrons is that of unwanted emissions. These generally take two forms: the first is amplification of an harmonic of the desired mode. The other form of unwanted emission is called moding; that is, significant cavity responses occurring at frequencies other than the frequency for which the magnetron is designed to operate.

Conventionally, harmonic emissions are reduced by means of external microwave filters or by employing complex output systems embodying integral filters.

The concept of strapping was devised as a solution to the problem of moding. Strapping, as conventionally understood, is the joining of alternate anode vanes by means of a closed ring. Each pair of vanes forms a resonant cavity therebetween, and all such cavities are maintained at the same electrical potential. Thus, alternate anode vanes are locked into operation in the desired mode, known as the π mode. The π mode has node points of the same distance apart as the distance between alternate vanes.

A problem has been encountered with conventional straps in that the currents that circulate in the straps to equalise the voltage on alternate vanes may also generate an electromagnetic field. This field may interfere with the operation and performance of the magnetron owing to its proximity to the cathode.

A proposed solution to this problem is that of providing a break in the strap. This prohibits the flow of current between the vanes that the strap connects. However, a drawback of this approach is that it increases the frequency separation of the modes of operation and may also cause oscillations at undesired frequencies.

The invention provides a magnetron comprising a plurality of anode vanes and a first strap in contact with alternate ones of the vanes, the strap having a protruding region.

The provision of protruding regions around the ring provides variations in capacitance between the strap and another strap or between the strap and the others of the anode vanes. This change in capacitance increases the stability of the magnetron in the wanted

mode, limits oscillations at undesired frequencies and reduces the coupling of harmonics into the cathode structure.

Preferably, a plurality of protruding regions is provided, the protrusions being spaced regularly around a portion of the strap.

Advantageously, the strap is adjustable, to allow the capacitance to be adjusted as required. This feature allows the user to retune the pi-1 mode to a different frequency range.

The invention further provides a strap arrangement for a magnetron comprising a first strap having a protruding region.

A plurality of straps may be provided, some or all of which may include at least one protrusion.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which: -

Figure 1 is a plan view of the anode and strap arrangement of a conventional magnetron;

Figure 2 is a perspective view of vanes of the anode arrangement of Figure 1;

Figure 3 is a graph illustrating magnetron output power against frequency, for a conventional magnetron;

Figure 4 is a plan view of the anode and strap arrangement of a magnetron constructed according to the invention;

Figure 5 is a graph illustrating magnetron output power against frequency, for the magnetron of Figure 4;

Figure 6 is a plan view of the anode and strap arrangement of an alternative magnetron constructed according to the invention;

Figure 7 is a perspective view of anode vanes and a strap arrangement of a magnetron constructed according to an alternative embodiment of the invention; and

Figure 8 is a perspective view of anode vanes and a strap arrangement of a magnetron constructed according to a further alternative embodiment of the invention.

Like reference numerals have been given to like parts throughout the specification.

With reference to Figures 1 and 2, a conventional typical anode arrangement is illustrated. The anode arrangement comprises a cylindrical anode wall, indicated

generally by the reference numeral 1, and a plurality of anode vanes, four of which 2-5 are illustrated in both Figures 1 and 2. The anode vanes extend radially inwardly from the inner wall of the cylindrical anode 1. A plurality of straps 6, 7, and 8 for the vanes are also illustrated. Strap 6 contacts alternate anode vanes, such as vanes 3 and 5, and is spaced from the other vanes, such as vanes 2 and 4. Cut-out regions 2', 2'' and 4', 4''in the vanes 2 and 4 respectively help to ensure that the strap 6 does not come into contact with these vanes. Strap 7 contacts those anode vanes that are not contacted by the strap 6 i.e. it contacts vanes 2 and 4. This strap is also spaced from the other alternate vanes, such as vanes 3 and 5. Similar cut-outs 3' and 5' in vanes 3 and 5 respectively help to ensure that the strap 7 does not come into contact with them. The third strap 8 is in contact with the same vanes as is the strap 6. The purpose of this extra strap is to balance the π mode r.f. field at the cathode. This is described in our UK Patent No.2054256.

The straps 6, 7, 8 comprise concentric rings, typically made of silver-plated copper. The rings shown in Figures 1 and 2 are open rings; i.e. they each have a so-called strap break 9 to 11 respectively. Typically, the breaks 9 to 11 are a little longer than the width of a vane, although this need not be the case. In this drawing, the strap breaks 9 to 11 are located over anode vanes, but other arrangements are possible. Although the strap breaks 9 to 11 are necessary to prohibit flow of current between the vanes, they tend to cause greater frequency separation between the π mode of operation and the π-1 mode. Furthermore, the strap breaks may cause oscillations at undesired frequencies.

The graph of Figure 3 represents the output of a conventional magnetron, such as that shown in Figures 1 and 2, across a range of frequencies (the X-band). The main output peak occurs at approximately 9.4 GHz, which represents the π mode, i.e., the desired mode of operation. However, there is a secondary peak occurring at approximately 9.9 GHz. This represents the undesired π -1 mode of operation. Power is also emitted at higher frequencies.

Figure 4 illustrates components of a magnetron constructed according to the invention. The anode arrangement is shown, which arrangement comprises a cylindrical anode 12 and a plurality of anode vanes 13 to 30 extending radially inwardly from the inner wall of the cylindrical anode. Two straps 31, 32 are also provided. The inner strap 31 comprises a ring attached to alternate ones of the vanes, for example vanes 13, 15, 17, 19, 21, 23, 25, 27 and 29. The outer strap 32, concentric with strap 31, is attached to the other vanes, in this instance vanes 14, 16, 18, 20, 22, 24, 26, 28 and 30.

In accordance with the invention, the outer strap 32 includes a plurality of protrusions 34 to 40. In this embodiment, the protrusions 33 to 40 project inwardly from the ring and are also periodically spaced around the ring. An exception to this is the portion that includes the strap break 41, which portion does not have a protruding region. The protrusions are arranged between the parts of the ring that are attached to the anode vanes. In other words, the protrusions are located adjacent the vanes that are not attached to the outer strap.

The protrusions 33 to 40 introduce a variation in capacitance between the inner strap 31 and the outer strap 32. Owing to the periodic spacing of the protrusions, there is a periodic variation in inter-strap capacitance. The protrusions create a "lumped" variation in capacitance, which has the effect of increasing stability of the pi mode. The invention also reduces the harmonic content of the pi mode, as well as limiting oscillations in the pi-1 mode.

The plot of Figure 5 illustrates the output power achievable with the present invention, across the same range of frequencies as that shown in Figure 3. The invention gives a cleaner spectrum of the desired pi mode at approximately 9.4 GHz and the secondary peak in Figure 3 representing the pi-1 mode is no longer present. It is also noticeable that the output at higher frequencies is markedly smaller than that shown in Figure 3.

In the embodiment shown in Figure 4, the protrusions take the form of inwardly indented regions of a ring-type strap. The diameter of the strap itself remains substantially constant around the ring, and so the outer edge of the strap protrudes inwardly to correspond with the inward indentations of the strap. Alternatively, as shown in Figure 6, the outer diameter of the ring can remain substantially constant, so that the outer edge of the strap 42 describes a circle. In this embodiment, the inward protrusions 43 to 50 cause a thickening of the diameter of the strap at the protruding regions. The provision of protruding regions causes a variation in separation between the inner and outer straps, thereby causing a variation in capacitance that has a stabilising effect on the magnetron.

The embodiments shown in Figures 4 and 6 show protrusions in the plane of the strap. In addition, or alternatively, protrusions may be arranged out of the plane of the strap. Examples are shown in Figures 7 and 8, which both illustrate a group of vanes 51 to 55 and an inner strap 56, but having different outer straps.

In Figure 7, the protrusions take the form of tabs 57, 58 attached to the inner edge of the outer strap 59. The tabs 57 and 58 are arranged to hang downwards, in a plane transverse to the plane of the strap 59. The tabs 57 and 58 are located close to the vanes 52 and 54, to which the strap is not attached. The tabs 57, 58 need not be located intermediate the attachment points; the tabs may also be located at the vanes to which the strap 59 is attached or at any other desired position.

Figure 8 illustrates an embodiment in which the protrusions extend in more than one plane. In this drawing, the protrusions take the form of indented regions 60, 61 and 62. Protrusions 60 and 61 occupy portions of the strap 63 intermediate the attachment points at vanes 51, 53 and 55. The strap 63 is arranged so that the protrusions 60 and 61 extend downwardly towards cut-out portions of the vanes 52 and 54. Protrusion 62, which is located close to the vane 53 to which the strap 63 is attached, is arranged to extend inwardly, i.e. towards the cathode.

In these drawings, the straps have been shown with protrusions extending inwardly or downwardly from the main body of the strap. The protrusions may be arranged to extend outwardly or upwardly from the strap. The protrusions need not be only in the

plane of, or perpendicular to, the strap. The protrusions may extend obliquely from the strap.

Alternatively, or additionally, the inner strap could have protrusions, and these need not extend in the same direction, or even in the same plane, as the protrusions on the outer strap. A plurality of straps may be employed, some or all of which may have protruding regions.

The straps need not be rigid; flexible straps may be employed, so that the extent of one or all of the protrusions may be adjusted. This arrangement allows for adjustment of the inter-strap or strap-to-vane capacitance. The provision of a variable capacitance permits the undesired pi-1 mode to be retuned to a different frequency range.

CLAIMS

1. A magnetron comprising a plurality of anode vanes and a first strap in contact with alternate ones of the vanes, the strap having a protruding region.

2. A magnetron as claimed in claim 1, wherein the strap has a plurality of protruding regions.

3. A magnetron as claimed in claim 2, wherein the protruding regions are substantially periodically spaced around at least a portion of the strap.

4. A magnetron as claimed in any previous claim, wherein the strap comprises an open ring.

5. A magnetron as claimed in any one of claims 1 to 3, wherein the strap comprises a closed ring.

6. A magnetron as claimed in any previous claim, in which the strap occupies a plane and at least some of the protrusions extend substantially in the plane.

7. A magnetron as claimed in any previous claim, in which the strap occupies a plane and at least some of the protrusions extend transversely to the plane.

8. A magnetron as claimed in any previous claim, wherein the strap is adjustable.

9. A magnetron as claimed in claim 8, wherein the strap is flexible.

10. A magnetron as claimed in any preceding claim, further comprising a second strap in contact with alternate others of the vanes.

11. A magnetron as claimed in claim 10, wherein the second strap includes at least one protruding region.

12. A magnetron as claimed in any preceding claim, including a plurality of straps, at least some of which have at least one protruding region.

13. A magnetron, substantially as hereinbefore described, with reference to, or as illustrated in, Figures 4, 6, 7 and 8 of the accompanying drawings.

14. A strap arrangement for a magnetron comprising a first strap having a protruding region.

15. An arrangement as claimed in claim 14, wherein the first strap includes a plurality of protruding regions.

16. An arrangement as claimed 15, wherein the protruding regions are substantially periodically spaced around at least a portion of the strap.

17. An arrangement as claimed in any one of claims 14 to 16, wherein the strap comprises an open ring.

18. An arrangement as claimed in any one of claims 14 to 16, wherein the strap comprises a closed ring.

19. An arrangement as claimed in any one of claims 14 to 18, in which the strap occupies a plane and at least some of the protrusions extend substantially in the plane.

20. An arrangement as claimed in any one of claims 14 to 19, in which the strap occupies a plane and at least some of the protrusions extend transversely to the plane.

21. An arrangement as claimed in any one of claims 14 to 20, wherein the strap is adjustable.

22. An arrangement as claimed in claim 21, wherein the strap is flexible.

23. An arrangement as claimed in any one of claims 14 to 22, further comprising a second strap.

24. An arrangement as claimed in claim 23, wherein the second strap includes at least one protruding region.

25. An arrangement as claimed in any one of claims 14 to 24, further comprising a plurality of straps, at least some of which have at least one protruding region.

26. A strap arrangement for a magnetron, substantially as hereinbefore described, with reference to, or as illustrated in Figures 4, 6, 7 and 8 of the accompanying drawings.